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United States
Department of
Agriculture

Forest Service
Forest Pest
Management

Davis, CA

Guidelines for Field Experiments and Pilot Projects - Aerial Application of Pesticides

FPM 92-5
April 1992

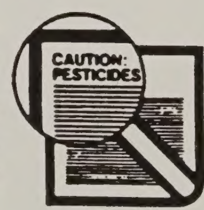
Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.



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April 1992

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PREFACE

This report contains guidelines for planning, conducting, and reporting field experiments and pilot projects involving pesticides applied by aircraft. The guidelines can also be used for testing of ground application systems. These were prepared in response to needs expressed by field units, Washington Office Forest Pest Management staff, and the National Steering Committee for Management of Western Defoliators. Regions, Northeastern Area, and Stations are familiar with procedures and practices set forth in the guidelines; however, cooperators and contractors are less familiar with the procedures and have requested guidance. The purpose of the guidelines, therefore, is to encourage test designs and procedures that are accepted within the Forest Service scientific community. Test data sets also should be comparable regardless of the testing organization. The applicable reference is USDA Forest Service Handbook 2109.14. Forest Pest Management extends its appreciation to those who contributed to the preparation and review of the guidelines.

FOREWORD

This report contains guidelines for planning, conducting, and reporting field experiments and pilot projects involving pesticides applied by aircraft. The guidelines can also be used for testing of ground application systems. These were prepared in response to needs expressed by field units, Washington Office Forest Pest Management staff, and the National Steering Committee for Management of Pesticide Applications. Regions, Northeastern Area, and Stations are familiar with procedures and practices now found in the guidelines; however, cooperators and contractors are less familiar with the procedures and have requested guidance. The purpose of the guidelines, therefore, is to encourage test designs and procedures that are accepted within the Forest Service scientific community. Test data will also prove to be acceptable regardless of the testing organization. The appropriate reference is USDA Forest Service Handbook 2109.14. Forest Pest Management extends its appreciation to those who contributed to the preparation and review of the guidelines.

RECOMMENDED GUIDELINES FOR DESIGN OF FIELD EXPERIMENTS OF INSECTICIDES FOR CONTROL OF INSECT DEFOLIATORS BY AERIAL APPLICATION

PURPOSE

The purpose of this document is to set forth some guidelines that can be used by private industry, consultants, and others in planning field tests for aerial application of insecticides to control forest defoliators. This document describes the types of parameters and experimental design considerations that Forest Service scientists consider when evaluating the results of an insecticide field experiment to determine whether it warrants pilot testing. These guidelines are not meant to be rigid unalterable criteria, or exhaustive, but they will serve as a focal point for discussion in planning insecticide field tests.

INTRODUCTION

The Forest Service, USDA, uses a progression of tests to evaluate and recommend various insecticides for use in operational resource protection. These include laboratory screening, field experiments, and pilot projects. Here, the term insecticides refers to any material distributed for the purpose of protecting a forest resource from insect pests, and may include agents that kill the pest with some form of toxicant, or other materials that prevent a necessary behavior such as feeding, mating, ovipositing, aggregation, etc. Field experiments are conducted to evaluate one or more of following; determine the minimum effective dosage rates, different strategies, or formulations of the same material, or different applications equipment. In contrast pilot projects evaluate the most promising treatments identified by field tests. Usually only one variable, for example dosage or volume, is evaluated and the plots are large enough to simulate operational conditions. These operational simulations include such items as uncontrolled multiple swaths, formulation and mixing characteristics of large quantities, use over wide variations in physical conditions etc.

Regardless of the type of program being conducted it is critical to state the objective clearly, concisely and as specifically as possible. The objective may be to estimate treatment effects (contrasting postspray populations levels in both treatment vs. control, or population reductions by treatment vs. control etc.) or specifications to be met (i.e. a treatment must reduce the population at least 90% to be judged effective). Some field tests of insecticides may be planned to determine the lowest effective dose to achieve a certain percent control or residual population for each treatment and to compare treatments. Usually, experiments with such general purposes are evaluated by analyses of variance (ANOVA) with appropriate contrast for determining differences in treatment means.

To arrive at an effective design for either hypothesis testing or point estimation we must consider variability and cost. Because the criteria for

judging effectiveness for the two goals are different, the design parameters, such as number of plots (replicates), number of trees (subsamples within a replicate) may differ. In many instances, however, both hypothesis testing and point estimation are important in a single field experiment. It seems reasonable then that the design parameters that meet the design criteria for one goal and exceed the criteria for another goal should be used.

All insecticides used by the USDA Forest Service are registered by the U.S. Environmental Protection Agency (EPA) under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended. However, additional research may need to be conducted on registered insecticides for the purpose of: (1) extending a registration to a new pest; (2) evaluating an insecticide's fate in the environment, (3) field testing an insecticides on a small scale, or (4) assessing environmental effects in specific forest habitats. When field tests are conducted on less than 10 cumulative acres, experimental use permits (EUP) are not required. If research is done on an unregistered pesticide on more than 10 acres then an EUP is required and the guidelines in 40 CFR 172 must be followed. In addition to EUP's, it is usually appropriate to prepare a Forest Service pesticide-use proposal (FS 2100-2) for review, concurrence, and approval of the intended use.

EXPERIMENTAL DESIGN

1. Treated Areas: The following should be considered when selecting areas to be aerially treated with pesticides:

(a.) First, the physiological health (quality) of the pest population should be known. Use of pest populations with recent history of stresses (i.e., acute competition for food, starvation, high virus incidence, recent epizootics, high level of parasitic activity of other chronic microbial infections) should be avoided if possible or at the very least noted. Using such populations of low quality could cause confounding effects and raise doubt concerning the reliability of the test results.

(b.) Block size should be based on two considerations: (a) mobility of the pest and (b) type of aircraft planned for use. Blocks of at least 20 acres should be used when the target pest is not mobile and blocks of at least 30 acres should be used if the target pest tends to be mobile. Helicopters should be used to treat small blocks.

2. Replication: The function of replication is to provide an estimate of experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects. The number of replications that will be required in a particular experiment depends on the magnitude of the differences to be detected and the variability of the data encountered. An experimental unit refers to the unit to which a treatment is applied. It can be a single leaf, an entire plant, or an area of ground containing many plants. Treatment replication is achieved when a treatment is randomly assigned to more than one experimental unit. Ensuring adequate replication

within the confines of applicable constraints, such as manpower and cost, usually requires that treatment plots be small, i.e. 20-50 acre plots.

3. Randomization: Randomization functions to assure unbiased estimates of treatment means and experimental error. When conducting a field experiment to establish the efficacy of aerially applied insecticide in forestry, it is recommended that 2 or more variables (e.g., dose and volume) be tested in the same experiment. It is also further recommended that each variable be replicated 5X (no less than 3X will be accepted) and all treatments (including the fully replicated control) are to be assigned at random.

4. Sampling: Depending on the insect species, an appropriate sampling design must be described in detail so that population estimates can be displayed with their attendant measures of variation (standard deviations, standard errors of the mean etc.). Efficacy testing will be evaluated using acceptable sampling designs. Treatment effects will be measured with, at minimum one pre-treatment and one post-treatment estimate of the pest population's density. It is also highly recommended that periodic measurements to estimate treatment effects on the pest population density or of the protective effect of the insecticide be made at different time intervals. These intervals should coincide with the pest's own development rate or at different developmental stages, during the pest's active (e.g. feeding) period.

5. Data Analyses: To account for treatment differences, given natural differences and sampling error, the variables of interest must be defined i.e. the ratio of insects to foliage after treatment vs. before treatment. An estimate of this variable or other variables of interest and the components of the variances of the estimates can be computed on the basis of ratios of the plot means. Usually, the experiment will be designed to test differences between dose levels, or between treatments and control, for a number of insecticides. In this example, analysis of the experiment will then be evaluated by a one-way ANOVA with plot ratios as observations (experimental units) and insecticides at various levels with control treatments. Establishing confidence intervals for the treatment means provide an additional set of statistics that can be used to determine differences between treatments.

REQUIRED ANCILLARY DATA

1. Plot Descriptions: It is often helpful to describe the stand characteristics within which the experiment was conducted. This can often be useful in extrapolating the results to other geographical areas other than where the original experiments were conducted.

2. Spray Measurements: At a minimum spray deposit cards should be used to obtain a verification of qualitative spray deposits.

3. Aircraft and Spray Characterization: Data must be provided that describes aircraft type, aircraft speed, flow rate, nozzle type, number of nozzles, swath width, volume delivered per acre/hectare, active ingredient per acre/hectare, drop size, some measure of droplet distribution, droplet density etc.

4. Product Quality: In some instances (e.g., microbial pesticides), it is appropriate to test for product potency (quality) prior to use of the product. This will require drawing a pre-treatment sample/s for bioassay. Analysis can be directed at determination of potency but can also be used to determine contamination if desired. With chemical insecticides it is recommended that tank samples be taken for each mixing batch for later determination of chemical concentration.

FURTHER CONSIDERATION

If desired, Forest Service personnel are available to review study plans prior to conduct of the field tests. To insure a timely and helpful review these study plans should be submitted to Director, WO-FPM, at least 45 days before test implementation.

DEFINITIONS

Analysis of Variance (ANOVA)- A statistical technique used to assess how several independent variables (ie. treatment groups) affect the mean(s) of the dependent variable (ie. insect population, defoliation). ANOVA is usually concerned with comparisons involving several (> 2) population means.

Control (Checks) - A series of experimental units (ie. plots) receiving either the standard treatment or no treatment, but included in the experiment under the same conditions as the treatment of interest (ie. insecticide) and not systematically different from them.

Experimental-Use Permit - A permit issued by the Environmental Protection Agency of a State to allow experimentation with an unregistered pesticide or to allow a new use of a registered pesticide. The permit is issued upon determination that the applicant needs such a permit to gather information necessary to register the pesticide for a new use (40 CFR 172, Experimental-Use Permits).

Field Test - A research project considering several insecticide treatment variables under a variety of field conditions.

Operational Project - A full scale control project designed to utilize the best treatment materials, equipment, techniques and strategies available to treat a problem (in this instance, a forest defoliator infestation).

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) and substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A special project that considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy under simulated operational conditions.

Randomization - The assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment

Registration - The process whereby the Environmental Protection Agency and States regulate the use of pesticides under authority of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

Replication - The randomized treatments (including controls) are repeated on 2 or more experimental units. Its function is to provide an estimate of experimental error or natural variation and reduce confounding factors when attempting to measure treatment effects.

Experimental Units - Area (plots) or objects (trees or leaves) that a single treatment is applied to and from which samples are drawn. The complete collection of these experiment units is the population to which inferences are made.

SELECTED REFERENCES

1. Williams, C.B. Jr., D.A. Sharpnack, L. Maxwell, P.J. Shea, and M. D. McGregor. 1985. Guide to testing insecticides on coniferous forest defoliators. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station. Gen. Tech. Rept. PSW-85. 38pp.

2. Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs. 54(2):187-211. (esp p199-204).

3. Little, T.M. and F.J. Hills. 1978. Agricultural Experimentation. Design and Analysis. J. Wiley and Sons. 350pp. (esp.p5-11)

4. Milliken, G.A. and D.E. Johnson. 1984. Analysis of Messy Data. Chap.4. Basics of Experimental Design. Lifetime Learning Publ. NY,NY. 398p. (esp. p47-50).

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RECOMMENDED GUIDELINES FOR DESIGN OF PILOT PROJECTS - AERIAL APPLICATION OF PESTICIDES

INTRODUCTION

General

The USDA Forest Service (FS) conducts pilot projects to evaluate operational use of pesticides, application systems, and strategies to manage forest pests. Generally, the FS requires that a pesticide, application system, or strategy, be pilot tested following research and development, and prior to operational use. Decisions to proceed with a pilot project are based upon current or projected needs of the FS and availability of research data to support the new technology. Pesticides, application systems, and strategies customarily are researched or developed through the field testing stage, by the FS, other agencies, universities, or the private sector prior to being evaluated on a pilot project. Occasionally circumstances may dictate that a pesticide, application system, or strategy be pilot tested prior to completing research and development. In such cases that may be a cooperative field test and pilot project, with characteristics of both types of testing, but with major emphasis on an operational-scale variable. Pilot project design and conduct will vary depending upon test objective, criteria, and evaluation criteria e.g., evaluating biological effectiveness vs evaluating engineering performance of a spray system.

Purpose

The purpose of this document is to set forth a set of broad guidelines for planning and conducting pilot projects involving aerial application of pesticides, application systems, and strategies that will be applicable to the FS. Persons intending to conduct pilot projects are encouraged to follow these guidelines.

Background

The agency (FS or State cooperator) intending to use the pesticide, application system, or strategy operationally usually will participate in conducting the pilot project. In the process of conducting the pilot project the agency prepares for operational deployment of the pesticide, application system, or strategy. Thus, the agency determines during the pilot project whether it can use the pesticide, application system, or strategy effectively under operational conditions. There are, however, circumstances when a contractor might be contracted to conduct all or portions of a pilot project; or circumstances when a pesticide manufacturer or other private entity may conduct a pilot project in cooperation with the FS or a State cooperator.

Scope

The scope of this document covers pilot projects to evaluate the operational use of aerial application of pesticides, application systems, and strategies. The guidelines are oriented toward pesticide application projects; however, they are also applicable to pilot project evaluation of equipment and strategies. These guidelines are for use by public agencies and the private sector.

Definitions

Administrative Project (Study) - A special project conducted for a special local need of a District or Forest. The project may or may not include an accepted statistical design.

Application Systems - Spray application equipment that may include two or more of the following: aircraft, nozzles, aircraft guidance system, spray monitoring equipment, and other new equipment.

Control (Checks) - A series of units (i.e., blocks or plots) receiving no treatment and/or a standard or referenced treatment; and included in the experiment or pilot project under the same conditions as the treatment.

Cooperative Field Test and Pilot Project - A field project conducted cooperatively by FIDR and FPM that meets objectives of both a field test and a pilot project, and that meets the statistical design criteria of a field test.

Demonstration - A special project to demonstrate effectiveness of a product, equipment, or strategy; with or without the benefit of an accepted statistical design.

Field Test - An experiment designed to evaluate several treatment variables under field conditions.

Operational Projects - A full scale control project designed to utilize the best treatment materials, equipment, techniques, and strategies available to treat a forest pest problem.

Pesticide - (1) Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or (2) any substance or mixture of substances intended for use as a plant growth regulator, defoliant, or desiccant.

Pilot Project - A project with an appropriate statistical design and controls that simulates an operational-scale action, and considers only a single treatment variable to determine the value of a new or improved material, technique, or strategy. More than one variable (e.g., pesticide), however, may be tested concurrently.

Randomization - The assignment of treatments to units so that all units have an equal chance of being selected.

Replication - A treatment (including controls) which is repeated on three or more project units. Its function is to provide an estimate of natural variation and reduce confounding factors when measuring treatment effects.

Standard Treatment - A treatment using a product, equipment, or strategy for which the effectiveness is known or predictable.

Strategy - An approach to manage a forest pest that may include but not be limited to timing of treatment; size and frequency of treatment; combination of control methods; and other proven and unproven approaches.

GUIDELINES

Work Plan

A work plan should be prepared by the performing agency and coordinated with all interested parties. The plan should include the who, why, what, when, where, and how of the project. The objective, sampling methods, and analyses should be clearly stated and described. Work plans should also include operational aspects to include schedule of events, responsibilities, health and safety requirements, and background information on the items being tested (e.g., pesticide labels, material safety data sheets, and equipment specifications). As a guideline, the work plan should include sufficient detail to allow another person or group to conduct the pilot project. The pilot project design should include data collection and analyses that collectively might explain failures and successes.

A typical work plan, therefore, should include the following sections:

1. Introduction and Background
2. Objectives and Tasks
3. Project Area Description Physical and Biological
4. Pesticide, Application System, or Strategy Description
5. Project and Statistical Design, and Application Timing
6. Pesticide and Equipment Handling Procedures
7. Field Sampling Procedures
8. Laboratory Procedures
9. Environmental Monitoring
10. Data Analysis
11. Administration, Organization, and Budget
12. Safety, Hazard Analyses, Product Label, and Material Safety Data Sheet.
13. Public Involvement
14. Reporting Results and Technology Transfer

Criteria for Selecting Treatment Block

Criteria for selecting treatment blocks for pilot projects will vary depending upon objectives, available areas, environmental concerns, and other practical considerations. Pilot projects require replication of treatments and

controls; therefore, blocks should be similar in size, elevation, exposure, stand composition, and in the case of pesticide application, the blocks should have comparable populations of pests. Treatment and control blocks should be spaced sufficiently apart to preclude drift from other blocks. All blocks should be monitored for drift contamination. Treatment blocks should be comparable in size to those that might be treated operationally. Size may range from a few acres (e.g., seed orchards and site preparation areas) to over a thousand acres (e.g., western spruce budworm control areas).

Criteria for Evaluation

A pilot project should have a sound statistical design. For reasons discussed above the design will vary from project to project. It is suggested that the statistical design be reviewed by a statistician, by a research specialist, and by future users of the technology being tested. Design of pilot projects should include control (check) blocks and appropriate replication of the test treatment. In cases where replication or control blocks are not feasible, the pilot project objectives should be reviewed, and consideration given to conducting some alternative evaluation such as a special demonstration or an administrative project. When this is done it should be with the understanding that project results will not be as meaningful as those of a field test or pilot project with appropriate replications and checks.

Control and treatment blocks should be selected randomly from a group of blocks with similar characteristics. A minimum of three replications for both treatment and control blocks is recommended. All treatment blocks should be selected randomly for treatment, even recognizing that practical considerations may argue otherwise for treatment blocks, in particular.

Measurement of Biological Processes

The selection of appropriate sampling procedures to obtain statistically accurate estimates of population densities and, when necessary, to monitor population development, is essential for the successful completion of any pilot project. Sampling procedures should be described in detail in the work plan and final report. Population estimates obtained as a result of following the selected sampling procedure should be displayed with their attendant measures of variation (standard deviations, standard errors of the mean, etc.). At a minimum at least one pre-treatment and one post-treatment population estimate using the selected sampling procedures must be made in both treated and untreated control blocks and the results reported. When treatment efficacy may be affected by proper timing in relation to the target pest population, pest and host phenology information, if known, describing the lifestage distribution of the population during treatment should be reported.

Most major target pests have published sampling procedures. Examples of publications dealing with sampling procedures for Douglas-fir tussock moth, western spruce budworm, and gypsy moth are listed below:

Douglas-fir tussock moth

Mason, R.R. 1970. Development of sampling methods for the Douglas-fir tussock moth, Hemerocampa pseudotsugata Lepidoptera: Lymantriidae). Can. Entomol. 102:836-45.

Mason, R.R. 1979. How to Sample Douglas-fir Tussock Moth Larvae. USDA Agricultural Handbook No. 547, 15 pp.

Western spruce budworm

Carolin, V.M.; Coulter, W.K. 1972. Sampling populations of western spruce budworm and predicting defoliation on Douglas-fir in eastern Oregon. Res. Pap. PNW-149. Portland, OR, 38 pp.

Mason, R.R.; Wickman, B.E.; Paul, H.G. 1989. Sampling western spruce budworm by counting larvae on lower crown branches. PNW-RN-486, 8pp.

Srivastava, N; Campbell, R.W.; Torgersen, T.R.; Beckwith, R.C. 1984. Sampling the western spruce budworm: fourth instar, pupae,and egg masses. Forest Science 30(4):883-892.

Gypsy moth

Wilson, R. W., Jr.; Fountaine, G. A. 1978. Gypsy Moth Egg-mass Sampling with Fixed and Variable Radius Plots. USDA Agricultural Handbook No. 523, 46 pp.

Kolodny-Hirsch, D. 1986. Evaluation of methods for sampling gypsy moth egg mass populations and development of sequential sampling plans. Environ. Ent. 15:122-7.

Dubois, N.; Reardon, R.; Kolodny-Hirsch, D. 1988. Field efficacy of the NRD-12 strain of Bacillus thuringiensis against gypsy moth. J. Econ. Ent. 81:1672-1677.

Sampling procedures for some target pests may not be adequately addressed in published literature. In these cases procedures should be selected based on recommendations made by recognized specialists.

In addition to the sampling requirements detailed above, several other procedures may help a potential user interpret the results, and thus improve the credibility and acceptance of pilot project results. Biological assays (tests of the performance of field applied pesticides in a controlled environment on susceptible lifestages of the target insect) help to ensure that reported differences between mortality rates in the treated and control blocks resulted from exposure to the pesticide. Measurement of the pesticide potency obtained by quantifying the amount of active ingredient in sub-samples of each field batch provides additional information on potential effectiveness of the pesticide. Implementing procedures within the pilot project to fill data gaps on the effects on non-target organisms are encouraged.

Measurement of Physical Processes

The physical environment may have a major impact on the performance of a pesticide, application system, or strategy. The physical environment, therefore, should be considered during project design, conduct, and data evaluation and described in the pilot project report. It is assumed that the pilot project will be conducted at a location that is physically comparable to where it may be deployed operationally. Topography (elevation, slope, surface cover, and soil types) and atmosphere (wind, temperature, and moisture) can have a dramatic influence on performance of a pesticides, application systems, or strategies. Procedures for monitoring the resulting data should be included in the report. For example, application success in a low elevation, moderate terrain may not be repeatable in higher elevations and more complex terrain. Similarly, atmospheric conditions combined with topographical factors, may have a dramatic influence on dispersion of sprays and performance of equipment.

Meteorological measurements should be collected to:

1. Aid in spot forecasting and scheduling.

2. Provide the project director input for operational decisions.

3. Document events for post-spray analysis, modeling, and legal reference.

Two references on forest meteorology are:

Ekblad, R. B., H. E. Cramer, and R. K. Dumbauld. 1978. Meteorological considerations and measurements. In: The Douglas-fir Tussock Moth: A Synthesis; Forest Service, Science and Education Agency, Technical Bulletin 1585. U.S. Department of Agriculture, Washington, D.C.

Schroeder, Mark J. and Charles C. Buck. 1977. Fire Weather Agriculture Handbook 360. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Measurement of Physical Performance

The pilot project should provide for acquisition of data to evaluate the physical performance of the pesticide, application system, or strategy. This often is overlooked by scientists who may focus primarily on biological results. To illustrate with an example - you are testing a proven pesticide against a defoliator that concentrates in the upper tree crown. The test did not meet your control expectations and you may have doubts about its effectiveness. Why did it not perform? To evaluate this poor performance you need data on spray deposition in upper crown, spray atomization, aircraft calibration and performance, aircraft application, physical properties and handling of the tank mix, as well as information discussed in paragraphs II, E.

Environmental Monitoring

Design and conduct of pilot projects should consider environment protection consistent with the National Environmental Policy Act. Equal protection should be provided on private, State, and Federal lands. The pilot project objective should include determining or evaluating potential environmental impact of the pesticide, application system, or strategy being tested. Recognizing that such data may have been obtained during field or development testing, it is important to recognize that the purpose of a pilot project is to evaluate performance under semi-operational conditions. As an example, drift may be minimal on a 20 acre block when sprayed by a small helicopter close to the canopy, over moderate terrain. Scaling up from a 20 acre field experiment to a pilot project may involve several thousand acres, the aircraft may be a large helicopter or fixed-wing that flies higher above the canopy, and the terrain more complex.

Drift is inevitable - but how much and is there an impact? Such data are needed for operational evaluations.

Pesticide Application Equipment, and Strategies

The system being evaluated on a pilot project should be the system that in all probability would be deployed operationally. The project may be for a pesticide, an item of application equipment, a strategy, or a combination of these three. The pesticide tank mix, the aircraft and atomizer type, and strategy to be evaluated on a pilot project should be the same system planned for operational use; recognizing practical considerations.

WO/FPM staff is available to assist in reviewing work plans and operation plans, and providing advice as requested.

Reporting Results

Timely reporting of pilot projects is essential to efficient use of the technology being evaluated. A preliminary report should be available within our months of completing the field operation and a final report within one year. In addition to results the report should include as appropriate the factors listed in paragraph II, A. Journal publications should be considered when appropriate. The preliminary report may be critical to budget planning of follow-on testing or for operational deployment of the tested product.

****

Draft 6-22-89 considered comments received from M.Ollieu, D.Hamel, and G.Daterman.

Draft 7-20-89 considered comments received from J.Weatherby, G.Daterman, R.Reardon, D.Hamel, and T.Hofacker.

Draft 8-31-89 considered comments received from WO-FIDR, WO-FPM (D.Hamel); NA (D.Kucera, J.Hanson, I.Millers); PNW (G.Daterman); R-6 (B.Ciesla); Idaho (L.Livingston); R-8 (J.W.Taylor); and R-2 (D.Johnson).

Draft 10-17-89 reflects written comments from I.Ragenovich and verbal comments received at the western defoliator committee meeting on 10-12-89.